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**UTILITY  
PATENT APPLICATION  
TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.

P3816

First Inventor

Mario Nemirovsky et al.

Title

Fetch and Dispatch Decoupling Mechanism for  
Multistreaming Processors

Express Mail Label No.

EL573446764US

**APPLICATION ELEMENTS**

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO:

Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 20231

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original and a duplicate for fee processing)
2. ☒ Applicant claims small entity status.  
See 37 CFR 1.27.
3. ☒ Specification [Total Pages  ]  
(preferred arrangement set forth below)
- Descriptive title of the invention
  - Cross Reference to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference to sequence listing, a table, or a computer program listing appendix
  - Background of the Invention
  - Brief Summary of the Invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
4. ☒ Drawing(s) (35 U.S.C. 113) [ Total Sheets  ]
5. Oath or Declaration [ Total Pages  ]
- a. ☒ Newly executed (original or copy)  
Copy from a prior application (37 CFR 1.63 (d))  
(for continuation/divisional with Box 17 completed)
- b. ☐ **DELETION OF INVENTOR(S)**  
Signed statement attached deleting inventor(s)  
named in the prior application, see 37 CFR  
1.63(d)(2) and 1.33(b).
6. ☐ Application Data Sheet. See 37 CFR 1.76

7. ☐ CD-ROM or CD-R in duplicate, large table or  
Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)
- a. ☐ Computer Readable Form (CRF)
- b. Specification Sequence Listing on:
- i. ☐ CD-ROM or CD-R (2 copies); or
- ii. ☐ paper
- c. ☐ Statements verifying identity of above copies

**ACCOMPANYING APPLICATION PARTS**

9. ☒ Assignment Papers (cover sheet & document(s))
10. ☐ 37 CFR 3.73(b) Statement ☒ Power of Attorney  
(when there is an assignee)
11. ☐ English Translation Document (if applicable)
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
13. ☐ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503)  
(Should be specifically itemized)
15. ☐ Certified Copy of Priority Document(s)  
(if foreign priority is claimed)
16. ☒ Other: Check for fees

17. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP)

of prior application No. \_\_\_\_\_/\_\_\_\_\_

Prior application information

Examiner

NA

Group / Art Unit

NA

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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24739

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Name (Print/Type)	Donald R. Boys	Registration No. (Attorney/Agent)	35,074
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## Certificate of Express Mailing

"Express Mail" Mailing Label Number: EL573446764US

Date of Deposit: 11/03/2000

Ref: Case Docket No.: P3816

First Named Inventor: Mario Nemirovsky et al.

Serial Number: NA

Filing Date: 11/03/2000

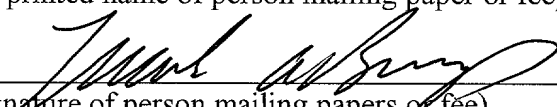
Title of Case: Fetch and Dispatch Decoupling Mechanism for Multistreaming Processors

I hereby certify that the attached papers are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and addressed to the Commissioner of Patents and Trademarks, Washington D.C. 20231

1. Utility patent application transmittal.
2. 12 sheets of specification.
3. 3 sheets of drawings.
4. Fee transmittal.
5. Duplicate fee transmittal.
6. Declaration and Power of Attorney.
7. Verified Statement Claiming Small Entity.
8. Recordation Cover Sheet.
9. Assignment.
10. Check for fees in the amount of \$395.00.
11. Certificate of express mailing.
12. Postcard listing contents.

Mark A. Boys

(Typed or printed name of person mailing paper or fee)

  
(Signature of person mailing papers or fee)

# FEE TRANSMITTAL for FY 2001

Patent fees are subject to annual revision.

TOTAL AMOUNT OF PAYMENT (\$ ) 395.00

## Complete if Known

Application Number	NA
Filing Date	11/03/2000
First Named Inventor	Mario Nemirovsky et al.
Examiner Name	NA
Group Art Unit	NA
Attorney Docket No.	P3816

## METHOD OF PAYMENT

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to.

Deposit  
Account  
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500 534

Deposit  
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- ☒ Charge Any Additional Fee Required  
Under 37 CFR 1.16 and 1.17

- ☒ Applicant claims small entity status  
See 37 CFR 1.27

2. ☒ Payment Enclosed:

- ☒ Check ☐ Credit card ☐ Money  
Order ☐ Other

## FEE CALCULATION

### 1. BASIC FILING FEE

Large Entity Small Entity

Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Description	Fee Paid
101	710	201	355	Utility filing fee	355.00
106	320	206	160	Design filing fee	
107	490	207	245	Plant filing fee	
108	710	208	355	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) (\$ ) 355.00

### 2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from below	Fee Paid
12	-20** = 0	9	0.00
2	-3** = 0	40	0.00
Multiple Dependent			0.00

Large Entity Small Entity

Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Description	Fee Paid
103	18	203	9	Claims in excess of 20	
102	80	202	40	Independent claims in excess of 3	
104	270	204	135	Multiple dependent claim, if not paid	
109	80	209	40	** Reissue independent claims over original patent	
110	18	210	9	** Reissue claims in excess of 20 and over original patent	

SUBTOTAL (2) (\$ ) 0.00

\*\*or number previously paid, if greater, For Reissues, see above

## FEE CALCULATION (continued)

### 3. ADDITIONAL FEES

Large Entity Small Entity

Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for <i>ex parte</i> reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	390	216	195	Extension for reply within second month	
117	890	217	445	Extension for reply within third month	
118	1,390	218	695	Extension for reply within fourth month	
128	1,890	228	945	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,240	241	620	Petition to revive - unintentional	
142	1,240	242	620	Utility issue fee (or reissue)	
143	440	243	220	Design issue fee	
144	600	244	300	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	40
146	710	246	355	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	710	249	355	For each additional invention to be examined (37 CFR § 1.129(b))	
179	710	279	355	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify) \_\_\_\_\_

\*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$ ) 40.00

## SUBMITTED BY

Name (Print/Type)

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(831) 726-1457

Signature

Date

11/03/2000

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**VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS  
(37 CFR 1.9(f) & 1.27(c))--SMALL BUSINESS CONCERN**

Docket Number (Optional)  
**P3816**

Applicant or Patentee: Mario Nemirovsky et al.  
Application or Patent No.: NA  
Filed or Issued: NA  
Title: Fetch and Dispatch Decoupling Mechanism for Multistreaming Processors

I hereby declare that I am  
☐ the owner of the small business concern identified below:  
☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF SMALL BUSINESS CONCERN XStream Logic, Inc.

ADDRESS OF SMALL BUSINESS CONCERN 750 University Ave, St. 270  
Los Gatos, CA 95032

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.12, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees to the United States Patent and Trademark Office, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time, or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention described in:

- ☒ the specification filed herewith with title as listed above.  
☐ the application identified above.  
☐ the patent identified above.

If the rights held by the above identified small business concern are not exclusive, each individual, concern, or organization having rights in the invention must file separate verified statements averring to their status as small entities, and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

- Each person, concern, or organization having any rights in the invention is listed below:  
☒ no such person, concern, or organization exists.  
☐ each such person, concern, or organization is listed below.

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that without false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING Dan O'Neill

TITLE OF PERSON IF OTHER THAN OWNER CEO

ADDRESS OF PERSON SIGNING 750 University Ave., Los Gatos, CA 95032

SIGNATURE *Dan O'Neill* DATE Nov 1 2000

# Fetch and Dispatch Decoupling Mechanism for Multistreaming Processors

*by inventors*

*Mario Nemirovsky, Adolfo Nemirovsky,  
Narendra Sankar and Enrique Musoll,*

## **Field of the Invention**

The present invention is in the field of digital processing and pertains more particularly to apparatus and methods for fetching and dispatching instructions in dynamic multistreaming processors.

## **Background of the Invention**

Conventional pipelined single-stream processors incorporate fetch and dispatch pipeline stages, as is true of most conventional processors. In such processors, in the fetch stage, one or more instructions are read from an instruction cache and in the dispatch stage, one or more instructions are sent to execution units (EUs) to execute. These stages may be separated by one or more other stages, for example a decode stage. In such a processor the fetch and dispatch stages are coupled together such that the fetch stage generally fetches from the instruction stream in every cycle.

In multistreaming processors known to the present inventors, multiple instruction streams are provided, each having access to the execution units. Multiple fetch stages may be provided, one for each instruction stream, although one dispatch stage is employed. Thus, the fetch and dispatch stages are coupled to one another as in other conventional processors, and each instruction stream generally fetches instructions in each

cycle. That is, if there are five instruction streams, each of the five fetches in each cycle, and there needs to be a port to the instruction cache for each stream, or a separate cache for each stream.

5 In a multistreaming processor multiple instruction streams share a common set of resources, for example execution units and/or access to memory resources. In such a processor, for example, there may be M instruction streams that share Q execution units in any given cycle. This means that a set of up to Q instructions is chosen from the M instruction streams to be delivered to the execution units in each cycle. In the following  
10 cycle a different set of up to Q instructions is chosen, and so forth. More than one instruction may be chosen from the same instruction stream, up to a maximum P, given that there are no dependencies between the instructions.

15 It is desirable in multistreaming processors to maximize the number of instructions executed in each cycle. This means that the set of up to Q instructions that is chosen in each cycle should be as close to Q as possible. Reasons that there may not be Q instructions available include flow dependencies, stalls due to memory operations, stalls due to branches, and instruction fetch latency.

20 What is clearly needed in the art is an apparatus and method to decouple dispatch operations from fetch operations. The present invention, in several embodiments described in enabling detail below, provides a unique solution.

### Summary of the Invention

In a preferred embodiment of the present invention a pipelined multistreaming processor is provided, comprising an instruction source, a plurality of streams fetching instructions from the instruction source, a dispatch stage for selecting and dispatching instructions to a set of execution units, a set of instruction queues having one queue associated with each stream in the plurality of streams, and located in the pipeline between the instruction source and the dispatch stage, and a select system for selecting streams in each cycle to fetch instructions from the instruction source. The processor is characterized in that the number of streams selected for which to fetch instructions in each cycle is fewer than the number of streams in the plurality of streams.

In some embodiments the number of streams in the plurality of streams is eight, and the number of streams selected for which to fetch instructions in each cycle is two. Also in some embodiments the select system monitors a set of fetch program counters (FPC) having one FPC associated with each stream, and directs fetching of instructions beginning at addresses according to the program counters. In still other embodiments each stream selected to fetch is directed to fetch eight instructions from the instruction cache.

In some embodiments there is a set of execution units to which the dispatch stage dispatches instructions. In some embodiments the set of execution units comprises eight Arithmetic-Logic Units (ALS), and two memory units.

In another aspect of the invention, in a pipelined multistreaming processor having an instruction queue, a method for decoupling fetching

from a dispatch stage is provided, comprising the steps of (a) placing a set of instruction queues, one for each stream, in the pipeline between the instruction queue and the dispatch stage; and (b) selecting one or more streams, fewer than the number of streams in the multistreaming processor, for which to fetch instructions in each cycle from an instruction source.

In some embodiments of the method the number of streams in the plurality of streams is eight, and the number of streams selected for which to fetch instructions in each cycle is two. In some embodiments the select system monitors a set of fetch program counters (FPC) having one FPC associated with each stream, and directs fetching of instructions beginning at addresses according to the to the program counters. In other embodiments each stream selected to fetch is directed to fetch eight instructions from the instruction source. In preferred embodiments, also, the dispatch stage dispatches instructions to a set of execution units, which may comprise eight Arithmetic-Logic Units (ALS), and two memory units.

In embodiments of the present invention, described in enabling detail below, for the first time apparatus and methods are provided for a decoupling fetch and dispatch in processors, and particularly in multistreaming processors.

### **Brief Description of the Drawings**

Fig. 1 is a block diagram depicting a pipelined structure for a processor in the prior art.

Fig. 2 is a block diagram depicting a pipelined structure for a multistreaming processor known to the present inventors.



Fig. 3 is a block diagram for a pipelines architecture for a multistreaming processor according to an embodiment of the present invention.

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### Description of the Preferred Embodiments

Fig. 1 is a block diagram depicting a pipelined structure for a processor in the prior art. In this prior art structure there is an instruction cache 11, wherein instructions await selection for execution, a fetch stage 13 which selects and fetches instruction into the pipeline, and a dispatch stage which dispatches instructions to execution units (EUs) 17. In many conventional pipelined structures there are additional stages other than the exemplary stages illustrated here.

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In the simple architecture illustrated in Fig. 1 everything works in lockstep. In each cycle an instruction is fetched and, and another previously fetched instruction is dispatched to one of the execution units.

Fig. 2 is a block diagram depicting a pipelined structure for a multistreaming processor known to the present inventors, wherein a single instruction cache 19 has ports for three separate streams, and a fetch is made per cycle by each of three fetch stages 21, 23 and 25 (one for each stream). In this particular case a single dispatch stage 27 selects instructions from a pool fed by the three streams and dispatches those instructions to one or another of three execution units 29. In this architecture the fetch and dispatch units are still directly coupled. It should be noted that the architecture of Fig. 2, while prior to the present invention, is not necessarily in the public domain, as it is an as-yet proprietary architecture known to the

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present inventors. In another example, there may be separate caches for separate streams, but this does not provide the desired de-coupling.

Fig. 3 is a block diagram depicting an architecture for a dynamic multistreaming (DMS) processor according to an embodiment of the present invention. In this DMS processor there are eight streams and ten functional units. Instruction cache 31 in this embodiment has two ports for providing instructions to fetch stage 33. Eight instructions may be fetched each cycle for each port, so 16 instructions may be fetched per cycle.

In a preferred embodiment of the present invention instruction queues 39 are provided, which effectively decouple fetch and dispatch stages in the pipeline. There are in this embodiment eight instruction queues, one for each stream. In the example of Fig. 3 the instruction queues are shown in a manner to illustrate that each queue may have a different number of instructions ready for transfer to a dispatch stage 41.

Referring again to instruction cache 31 and the two ports to fetch stage 33, it was described above that eight instructions may be fetched to stage 33 via each port. Typically the eight instructions for one port are eight instructions from a single thread for a single stream. For example, the eight instructions fetched by one port in a particular cycle will typically be sequential instructions for a thread associated with one stream.

Determination of the two threads associated with two streams to be accessed in each cycle is made by selection logic 35. Logic 35 monitors a set of fetch program counters 37, which maintain a program counter for each stream, indicating at what address to find the next instruction for that stream.

Select logic 35 also monitors the state of each queue in set 39 of instruction queues. Based at least in part on the state of instruction queues 39 select logic 35 determines the two threads from which to fetch instructions in a particular cycle. For example, if the instruction queue in set 39 for a stream

is full, the probability of utilizing eight additional instructions into the pipeline from the thread associated with that stream is low. Conversely, if the instruction queue in set 39 for a stream is empty, the probability of utilizing eight additional instructions into the pipeline from the thread associated with that stream is high.

In this embodiment, in each cycle, four instructions are made available to dispatch stage 41 from each instruction queue. In practice dispatch logic is provided for selecting from which queues to dispatch instructions. The dispatch logic has knowledge of many parameters, typically including priorities, instruction dependencies, and the like, and is also aware of the number of instructions in each queue.

As described above, there are in this preferred embodiment ten execution units, which include two memory units 43 and eight arithmetic logic units (ALUs) 45. Thus, in each cycle up to ten instructions may be dispatched to execution units.

In the system depicted by Fig. 3 the unique and novel set of instruction queues 39 provides decoupling of dispatch from fetch in the pipeline. The dispatch stage now has a larger pool of instructions from which to select to dispatch to execution units, and the efficiency of dispatch is improved. That is the number of instructions that may be dispatched per cycle is maximized. This structure and operation allows a large number of streams of a DMS processor to execute instructions continually while permitting the fetch mechanism to fetch from a smaller number of streams in each cycle. Fetching from a smaller number of streams, in this case two, in each cycle is important, because the hardware and logic necessary to provide additional ports into the instruction cache is significant. As an added benefit, unified access to a single cache is provided.

Thus the instruction queue in the preferred embodiment allows fetched instructions to be buffered after fetch and before dispatch. The instruction queue read mechanism allows the head of the queue to be presented to dispatch in each cycle, allowing a variable number of instructions to be dispatched from each stream in each cycle. With the instruction queue, one can take advantage of instruction stream locality, while maximizing the efficiency of the fetch mechanism in the presence of stalls and branches. By providing a fetch mechanism that can support up to eight instructions from two streams, one can keep the instruction queues full while not having to replicate the fetch bandwidth across all streams.

The skilled artisan will recognize that there are a number of alterations that might be made in embodiments of the invention described above without departing from the spirit and scope of the invention. For example, the number of instruction queues may vary, the number of ports into the instruction cache may vary, the fetch logic may be implemented in a variety of ways, and the dispatch logic may be implemented in a variety of ways, among other changes that may be made within the spirit and scope of the invention. For these and other reasons the invention should be afforded the broadest scope, and should be limited only by the claims that follow.

What is claimed is:

1. A pipelined multistreaming processor, comprising:

an instruction source;

5 a plurality of streams fetching instructions from the instruction source;

a dispatch stage for selecting and dispatching instructions to a set of execution units;

10 a set of instruction queues having one queue associated with each stream in the plurality of streams, and located in the pipeline between the instruction source and the dispatch stage; and

a select system for selecting streams in each cycle to fetch instructions from the instruction source;

15 characterized in that the number of streams selected for which to fetch instructions in each cycle is fewer than the number of streams in the plurality of streams.

20 2. The processor of claim 1 wherein the number of streams in the plurality of streams is eight, and the number of streams selected for which to fetch instructions in each cycle is two.

25 3. The processor of claim 2 wherein the select system monitors a set of fetch program counters (FPC) having one FPC associated with each stream, and directs fetching of instructions beginning at addresses according to the to the program counters.

4. The processor of claim 2 wherein each stream selected to fetch is directed to fetch eight instructions from the instruction cache.

5. The processor of claim 1 further comprising a set of execution units to which the dispatch stage dispatches instructions.

5 6. The processor of claim 5 wherein the set of execution units comprises eight Arithmetic-Logic Units (ALUs), and two memory units.

10 7. In a pipelined multistreaming processor having an instruction queue, a method for decoupling fetching from a dispatch stage, comprising the steps of:

(a) placing a set of instruction queues, one for each stream, in the pipeline between the instruction queue and the dispatch stage; and

15 (b) selecting one or more streams, fewer than the number of streams in the multistreaming processor, for which to fetch instructions in each cycle from an instruction source.

20 8. The method of claim 7 wherein the number of streams in the plurality of streams is eight, and the number of streams selected for which to fetch instructions in each cycle is two.

25 9. The method of claim 8 wherein the select system monitors a set of fetch program counters (FPC) having one FPC associated with each stream, and directs fetching if instructions beginning at addresses according to the to the program counters.

10. The method of claim 7 wherein each stream selected to fetch is directed to fetch eight instructions from the instruction source.

11. The method of claim 6 wherein the dispatch stage dispatches instructions to a set of execution units.

12. The method of claim 11 wherein the set of execution units comprises eight Arithmetic-Logic Units (ALS), and two memory ports.

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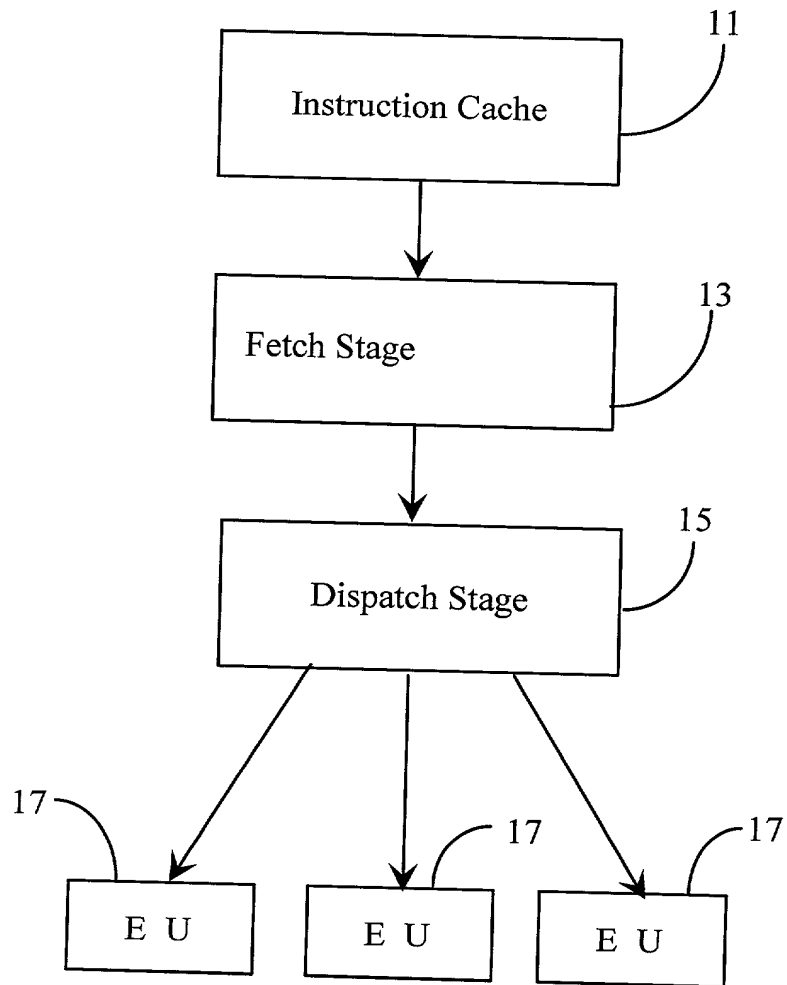
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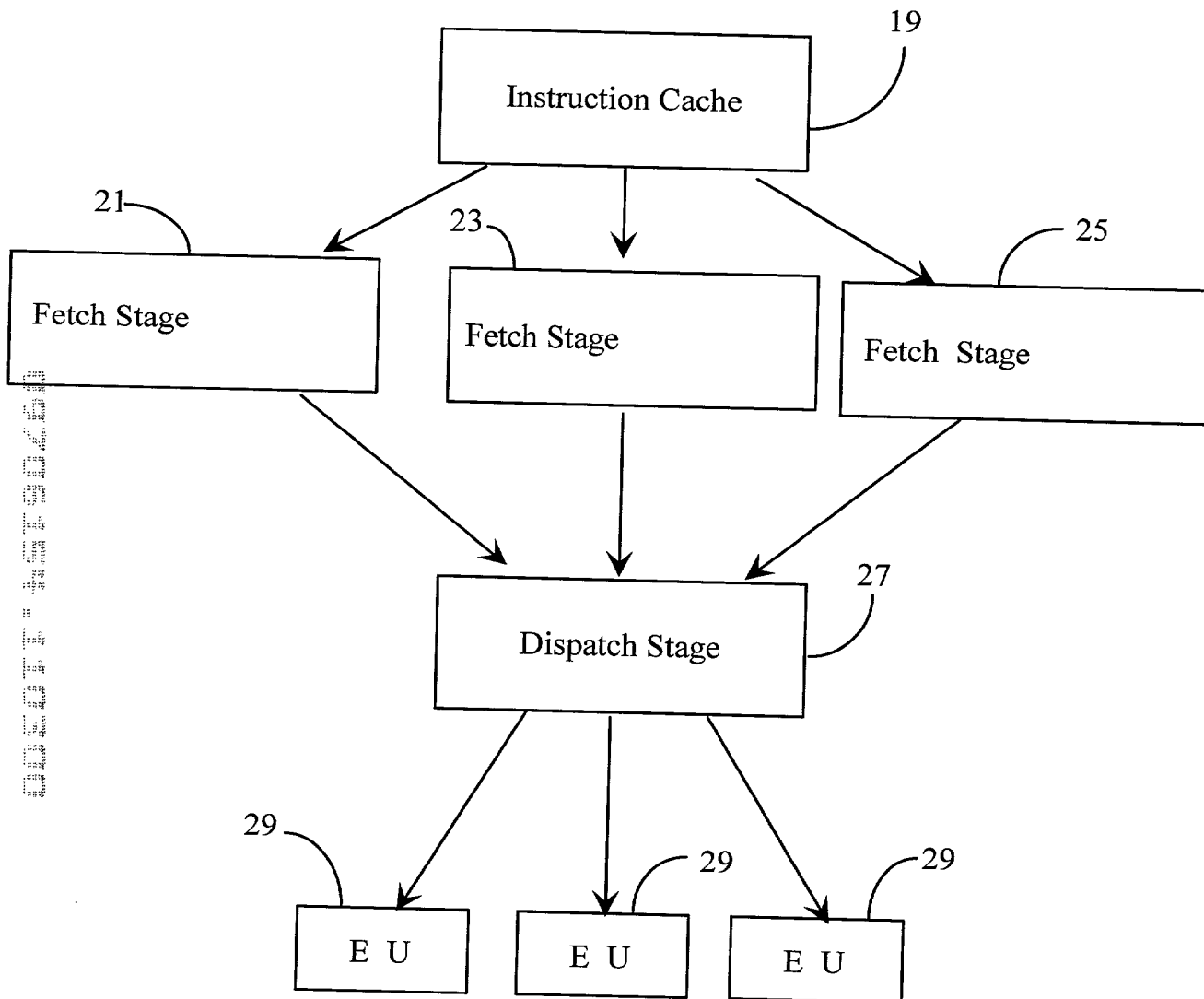
### Abstract of the Disclosure

A pipelined multistreaming processor has an instruction source, a plurality of streams fetching instructions from the instruction source, a dispatch stage for selecting and dispatching instructions to a set of execution units, a set of instruction queues having one queue associated with each stream in the plurality of streams, and located in the pipeline between the instruction cache and the dispatch stage, and a select system for selecting streams in each cycle to fetch instructions from the instruction cache. The processor is characterized in that the select system selects one or more streams in each cycle for which to fetch instructions from the instruction cache, and in that the number of streams selected for which to fetch instructions in each cycle is fewer than the number of streams in the plurality of streams.

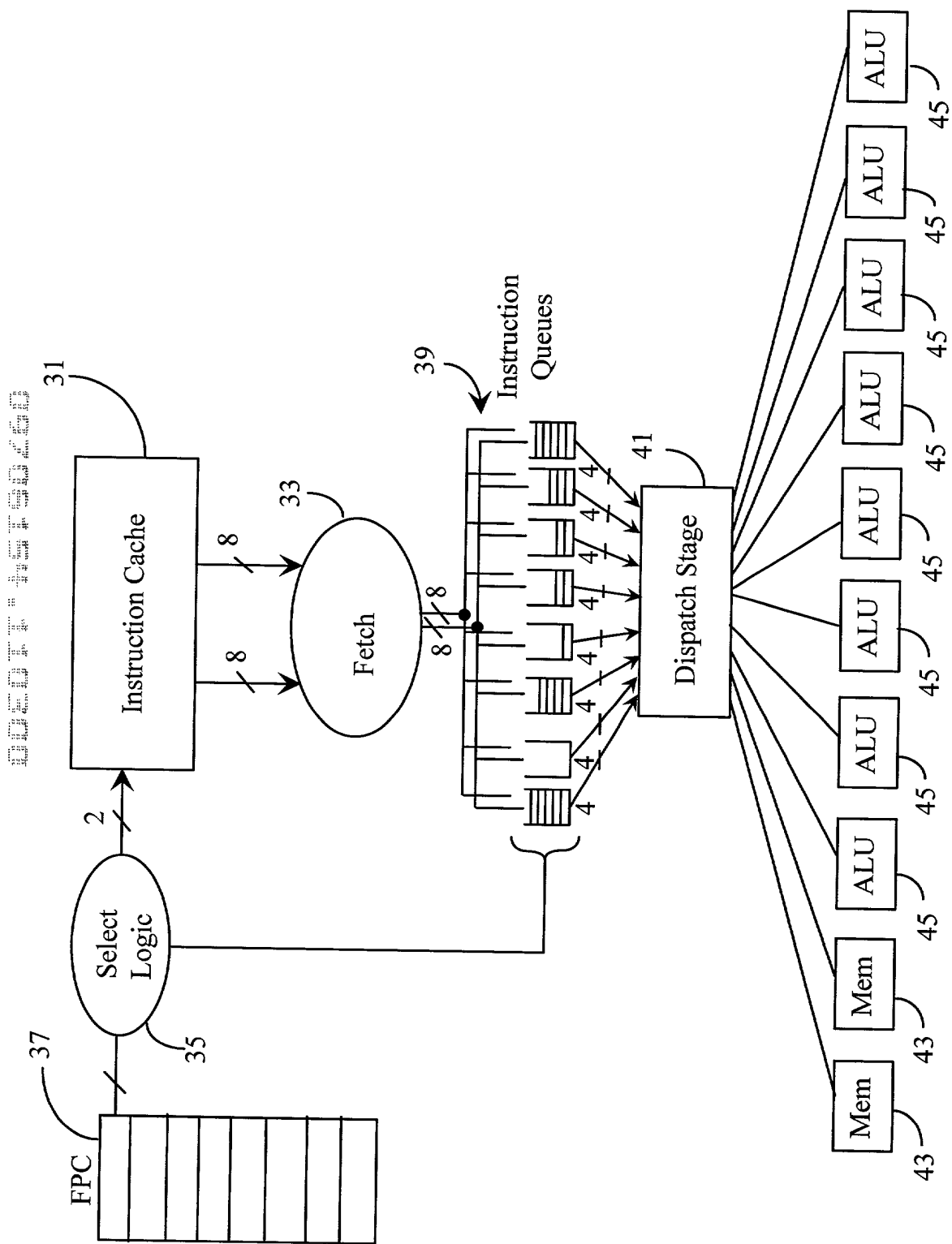




***Fig. 1 (Prior Art)***



**Fig. 2**



**Fig. 3**

## DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

ATTORNEY DOCKET NO. **3816**

As a below named inventor, I hereby declare that: My residence, post office address and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **Fetch and Dispatch Decoupling Mechanism for Multistreaming Processors**

the specification of which (check one) ☒ is attached hereto.

☐ was filed on:

☐ Application Serial No.

☐ and was amended on

(If applicable)

I hereby state that I have reviewed and understood the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56 (a). In the case that the present application is a continuation-in-part application, I further acknowledge the duty to disclose material information as defined in 37 CFR § 1.56(a) which became available between the filing date of the prior application and the filing date of the present application. I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign applications for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

(Number) (Country) (Day/Month/Year Filed)

(Number) (Country) (Day/Month/Year Filed)

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.): (Filing Date): (Status):

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(Application Serial No.): (Filing Date): (Status):

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.  
(List name and registration number)

Name: Donald R. Boys

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Marlo Nemirovsky

1st inventor's signature: [Signature]

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Post Office Address: Same

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2nd inventor's signature: [Signature]

Dated: 10/31/00

Residence: 1044 Alderbrook Lane, San Jose, CA 95129 Citizenship: US

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Full name of 3rd joint inventor, if any: Narendra Sankar

3rd inventor's signature: [Signature]

Dated: 10/31/00

Residence: 35 Sunnyside Ave., Campbell, CA 95008 Citizenship: India

Post Office Address: Same

Full name of 4th joint inventor, if any: Enrique Musoll

4th inventor's signature: [Signature]

Dated: 10/31/00

Residence: 7210 Via Romera, San Jose, CA 95139 Citizenship: Spain

Post Office Address: Same

Full name of 5th joint inventor, if any:

5th inventor's signature: \_\_\_\_\_

Dated: \_\_\_\_\_

Residence: \_\_\_\_\_ Citizenship: \_\_\_\_\_

Post Office Address: \_\_\_\_\_

Full name of 6th joint inventor, if any:

6th inventor's signature: \_\_\_\_\_

Dated: \_\_\_\_\_

Residence: \_\_\_\_\_ Citizenship: \_\_\_\_\_

Post Office Address: \_\_\_\_\_

Full name of 7th joint inventor, if any:

7th inventor's signature: \_\_\_\_\_

Dated: \_\_\_\_\_

Residence: \_\_\_\_\_ Citizenship: \_\_\_\_\_

Post Office Address: \_\_\_\_\_

Full name of 8th joint inventor, if any:

8th inventor's signature: \_\_\_\_\_

Dated: \_\_\_\_\_

Residence: \_\_\_\_\_ Citizenship: \_\_\_\_\_

Post Office Address: \_\_\_\_\_